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LOS ANGELES COUNTY

HUNTER OF THE NIGHT

Article and photographs by Manabu Miyazaki

THE OWL HAS BEEN VARIOUSLY EXALTED or loathed at given times and places. This range of emotion demonstrates the extent to which humans feel intrigued by this bird. No bird fascinates us like the owl.

I was driving one evening through a town of widely scattered houses in Nagano Prefecture, Japan. As I passed a row of large buildings, an imposing bird flew off a telephone pole right in front of my car. The size and wing movement of the bird, seen in the beam of my headlights, told me it was an owl. The buildings were poultry houses lined up like an apartment complex; each was brightly lit to keep the chickens awake and increase egg production. It occurred to me that tons of feed were used in those buildings, some of which would end up in the stomachs of gully mice and black rats. The owl's staple food is field mice, and to find them, this owl was willing to venture among human structures near the center of town.

What did this mean? That a new strain of owls had adapted to human structures? If so, I might be able to penetrate the cloak of wooded darkness that has so hampered studies of this animal. If I could find a good observation field, I could watch owls all year round. I began my search.

Owl Valley is located near Nakagawa Village in Nagano Prefecture. Twenty years earlier, I had studied the young-rearing practices of owls in this same valley, and upon returning I found that several of the nests that I had observed then were still in active use. I also found, however, that the forest surrounding the owl nests had been lumbered and reforested some years back. Reforested areas are full of field mice, but without tall trees to perch on, these make poor hunting areas for owls. The owl's hunting strategy is to alight on top of a tree with a good view and wait for a field mouse or other prey to come along. The young trees now dominating the valley's slopes could not offer the owls the perches essential for their survival.

I decided to bring some dead trees into Owl Valley and stand them up. This proved highly successful. By the third day I found owl traces on all three of the trees I had propped up on the slope. Stuck to branches were needle-thin hairs like those that grow on owls' talons. Encouraged by this start, I began collecting more detailed data. To each of the perch trees I attached a sensor equipped with an electromagnetic counter to give me a rough idea of the nightly use rate for each tree. The higher the number on the counter in the morning, the more the tree had been visited during the night. The counter told me that each tree was visited three to seven times, and that this frequency was uniform throughout the month.

I moved around the valley very carefully, trying to read each sign given by the owls and hoping these clever animals would not dislike me. From the beginning I decided I would only observe them from inside a tiny hut I constructed. All I needed from the hut was to be housed each night, curled up in a sleeping bag, so I made it a small plywood affair of about 10 feet square.

Next I brought electricity to Owl Valley because I needed light in order to observe the owls at night. The distance from the village through the logging road to Owl Valley was almost a mile. After erecting and wiring sixteen electric poles, I ran low wattage through the wires to accustom the owls to dim lights. I waited, then raised the illumination slightly and gave them time to accept the stronger lighting. I increased the illumination at regular intervals and after several days the entire valley was lit up every night.

Right: **With prey in view, a Ural Owl leaves its perch, flying at a speed of 30 feet per second. Its usually invisible wing movements are revealed here by eight strobe exposures per second.**

Cover: **The strobe catches the owl braking its flight with wings and tail at the instant before it reaches a perch. Photograph copyright 1990 Manabu Miyazaki.**

Throughout the lighting process I tried to hide from the owls the fact that a human was behind these changes. The project was large scale, but I was as discreet as possible: the owls demonstrated no misgivings whatsoever about inhabiting a valley now in the vanguard of technology.

Every night I was captivated by new discoveries and surprises. The first year went by quickly. I was so transfixed by the owls that I spent 200 nights in my hut in the valley. After a while, the owls recognized me. When I was taking pictures, though, they ignored me and continued to behave naturally. I was fascinated by these animals that have been so revered by many cultures.

The owl is a bird of prey like the eagle or hawk. During previous research I had observed the nesting behavior of all sixteen species of eagles and hawks inhabiting Japan. All were fierce and fascinating; each species and each individual had its own character and personality. Tracking birds of prey was fascinating because of the opportunity to observe these separate personalities up close and respond accordingly. When I made these birds the objects of my study, however, I saw that the more absorbed I became in them, the more wary of me they became. The more I tracked eagles and hawks, the more they read my actions and hid from me the behaviors I wanted to see. On the other hand, when I was eating, reading, trying to nap, or listening to the radio, they paraded their lives in front of me. As soon as I understood this, I did all I could to ease their anxiety.

Later, when I began observing the owls in the valley, I employed from the start the strategy of affected unconcern that I had developed in my earlier studies. When it was appropriate to be discreet, I was the soul of circumspection, but when I was not attending to them I moved about brazenly. When I shut myself up in the hut, I was elaborately unconcerned with whether owls appeared or not. Nothing could have hurt my purposes more than to show an intense and expectant face at the window, my eyes darting around to catch every movement. Therefore, my tent life was a lackadaisical round of reading, drinking saki, and napping.

Of course, without the assurance that my sensors were picking up each and every owl visiting my trees, I probably could not have managed such a nonchalant attitude. When I heard the sound *pi pi pi pi,* a bird had alighted on the left perch. When it was the right perch I heard *bi bi bi bi; bu bu bu bu* meant an owl had landed on the middle perch. At each of these sounds I would look out the appropriate window to see the bird on the appropriate perch.

On the face of it, my methods might appear shamefully lazy, but my technique was developed through long experience. Almost no wildlife today completely rejects human structures. Such structures have inundated the natural world so much that animals have become accustomed to them. Daily experience teaches wildlife which human structures pose a threat. I decided to take advantage of this tolerance and employ advanced technology to the maximum extent; what my fancy machines could not tell me, I would seek through traditional methods of direct observation.

Three years passed. The owls came to Owl Valley every day. They raised their young there. Knowing full well that I sat in my little observation hut, the families never hesitated to show themselves. They had carefully evaluated me and judged me safe, provided I maintained a certain distance.

Mr. Miyazaki, one of Japan's leading nature photographers, was born in 1949 and has been a wildlife photographer since 1972. His striking images of the Ural Owl (Strix uralensis), *a relative of the North American Spotted Owl and Barred Owl, were first published by Heibonsha Press and later released in an English-language edition,* The Owl: A Photographic Essay, *by Chronicle Books of San Francisco (1990); this article was adapted from the book.*

An owlet stretches in its nest hole in a huge red pine. A pair of owls will nest in the same tree year after year; the fact that they are indifferent to the tree during the nonbreeding seasons allowed Mr. Miyazaki to set up remote controlled cameras, focused inside the cavity and preloaded with 750-exposure film, before the nest was put to use once again.

THE TYRANT LIZARD KING

TYRANNOSAURUS REX, or *T. rex* as it is commonly known, is a unique dinosaur in many ways. Even its name receives special respect. While every dinosaur has a two-part species name, how many people have ever heard of the *stenops* in *Stegosaurus stenops* or the *horridus* in *Triceratops horridus*? Yet everyone knows *rex*, the species name that means "king" and combines with *Tyrannosaurus*, or "tyrant lizard," to translate as "the tyrant lizard king."

There are at least half a dozen other species in the family Tyrannosauridae and some additional species based on fragmentary material that also probably belong in the group as well. All these specimens have been found in eastern Asia or North America; they are from animals that lived during the latter two-thirds of the Late Cretaceous—the last 20 million years of the Mesozoic Era and the final one-seventh of the time that the dinosaurs existed.

Besides tyrannosaurids, there were several other families of carnivorous dinosaurs; each was characterized by a particular suite of features. One of these other families is the Allosauridae, of which *Allosaurus fragilis* is the best known example. The largest *A. fragilis* specimen is almost as big as a *T. rex*, but the two can be immediately distinguished from one another by counting fingers: *T. rex* has two digits on each "hand," while *A. fragilis* has three fingers at the end of each of its significantly larger forearms. Other readily apparent differences involve the head. *T. rex*'s is proportionally larger and is supported by a much shorter and stockier neck. These distinguishing features are generally found in all species of tyrannosaurids and allosaurids, but in the case of *T. rex*, they are carried to an extreme.

Because *Allosaurus fragilis* and allosaurids flourished much earlier than tyrannosaurids, having arisen by the Middle Jurassic—about 170 million years ago, scientists long thought that they were the ancestors of the tyrannosaurids. However, with the discovery and intensive study of many smaller carnivorous dinosaurs during the past 30 years, these two families of large carnivorous dinosaurs are now regarded as only remotely related.

The small forearms, large head, and short, stout neck of *T. rex* are the culmination of a trend in the evolution of tyrannosaurids that went no further: *T. rex* was the last of the tyrannosaurids and may have gone extinct for reasons quite unrelated to its extreme specializations. Many other, quite unrelated animals disappeared at the same time—about 65 million years ago, when all the dinosaurs except birds went extinct. And so it is not clear whether these specializations of the neck, head, and forelimbs could have been carried further than their development had reached in *T. rex* if the tyrannosaurids had survived into the Cenozoic Era, the Age of Mammals.

When you examine a skeleton or accurate model of *T. rex* and begin to ponder how this bipedal animal stood on its hind legs, there appears to be a problem. With the large head and stout body forward of the hind limbs, it would seem that unless *T. rex* were very careful, it would have been in grave danger of falling on its face. However, in the case of *T. rex*, there is less there than meets the eye: the skull is not formed of solid bone. Instead, the evolutionary process has taken the reduction of the skull's mass to an extraordinary stage. The skull can be likened to that of an eagle or other bird of prey in terms of weight reduction. Many of the cranial bones were hollow, with air passages linking these cavities to the lungs to accommodate changes in atmospheric pressure, just as they do in living birds. This is not altogether surprising because birds are thought to have evolved from ancestors among the carnivorous dinosaurs.

The foremost living student of the skull of *T. rex* is Ralph Molnar of the Queensland Museum in Brisbane, Australia. Dr. Molnar has not only described the

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THE GREAT HORNED FACES

THE WORLD WAS FIRST introduced to the bizarre nature of the ceratopsians—the "great horned faces"—in 1889. The skull of *Triceratops horridus* (meaning "three-horned and dreadful") was described at this time by one of the great early students of paleontology, O. C. Marsh, a professor at Yale University. Although a plant eater, the impressive creature he described, with its frill and horns and immense size, was a beast of nightmares.

Not all ceratopsians were so well endowed as *Triceratops*, and some actually had no horns at all. *Psittacosaurus*, a very primitive member of this group, had a parrotlike nipping beak very similar to that of *Triceratops* but no horns and no frill. *Protoceratops*, another relative from the Flaming Cliffs of Mongolia, had no horns either, just a beautiful frill. Then there were horned dinosaurs with far more decoration: *Centrosaurus* had a large rhinolike horn on its nose; and to take things to the ridiculous, *Pentacratops* was equipped with a nose horn, two horns just above the eyes, and two more bony horns on the cheeks.

So, why all the horns? Much ink has been spilled over this by paleontologists, but a look at the horned animals of today's world gives some hint of the purpose of these feature—for defense and in contests of dominance. Horns also must have been important for species recognition. There is no use fighting for dominance, getting a harem together, and then trying to spread your genes if it is with the wrong sort of animal, one not of your own species. And females need not bother with the horny fellow that has the wrong combination of bumps, blips, and frills on his head, because no offspring will result. Different horn shapes and arrangements among the ceratopsians could have helped each animal find the right mate, just as they do among today's African antelopes when many species herd in the

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skull in detail but also has subjected it to a stress analysis, much as an engineer might analyze a bridge. He has found that along the midline of the top of the skull there is a series of solid bones extending from the snout to the point where the skull attaches to the vertebral column. Otherwise, the skull is formed for the most part of weight-saving, hollow bones. In addition, bone is entirely absent in parts of the skull where there is no need for much rigidity. In contrast, in other dinosaurs these same regions of the skull are commonly formed of bone. Evidently, the skulls of the other dinosaurs were not under strong mechanical constraints to reduce their weight.

Weight reduction strategies are evident in other parts of the skeleton of *T. rex*. While the top and bottom edges of the dentary—the tooth-bearing element of the lower jaw—are thick, they are linked by a thin, vertical sheet of bone. In other dinosaurs, the dentary is typically of uniform thickness from top to bottom, with no sheet of thin bone developed. In addition, the vertebrae of *T. rex*'s back and shortened neck are hollow, as are its upper arm and thigh bones.

The extreme reduction in the size of the *T. rex* forelimbs may have been part of this weight reduction strategy as well. Their diminutive nature does not necessarily mean that the forelimbs of *T. rex* were useless appendages. An emu cannot fly, but as one runs over broken ground and dodges obstacles, its highly reduced wings are extended and constantly shifted in orientation as it employs them to maintain its balance. Although one specialist, Jack Horner (Museum of the Rockies, Bozeman, Montana), champions the view that the forelimbs of *T. rex* were useless as organs to assist in feeding, another, Ken Carpenter (Denver Museum of Natural History), advocates a more active role for them. Dr. Carpenter points out that muscle scars on the humerus or upper arm bone of *T. rex* are quite pronounced, suggesting that there were very prominent muscles attached there. This is hardly what you would expect of a vestigial organ.

It thus appears that *T. rex* was putting all its eggs in one functional basket, emphasizing the skull and dentition at the expense of other parts of the body. One does not ordinarily think of the mass of the teeth of an animal as a significant component of its total weight except in extreme instances, such as an elephant and its tusks. But the majority of the fifty teeth found in the mouth of the *T. rex* are each 1 foot long and an inch and a half in diameter. Such massive teeth total about 40 pounds in weight, a significant part of the total weight of the head. By contrast, the dentition of a lion weighs less than 2 pounds: proportionally about half as much of the total body mass in this modern predator is devoted to teeth.

The eight teeth at the front of the skull of *T. rex* are smaller than those behind. Their function was similar to that of human incisors—to initially grab prey. The larger teeth behind were then called into play to cut up the flesh of the victim once it was within the grasp of the *T. rex*. In the earlier carnivorous dinosaurs, as the animal closed its mouth, the teeth of the upper and lower jaws came together from the back forward, much like a pair of scissors. By contrast, in *T. rex*, all the teeth came together at once. This difference may have been critical in enabling *T. rex* to successfully subdue its prey without the assistance of its forelimbs.

Unlike in *Allosaurus*, the teeth of *T. rex* are curved rather than straight over much of their length. The degree of curvature increases toward the back of the jaw. The change in curvature means that each tooth is shaped like a segment of a circle, the center of which is the hinge between the lower jaw and the skull. As a result of this, the tooth would sink into flesh or bone with the minimum of resistance, and sideways cutting by the shaft of the tooth would be reduced to a minimum.

Harry Jerison of UCLA noticed an interesting phenomenon 30 years ago. He found that for a given body weight, the mass of the brain of a bird or mammal is about ten times that of a fish, amphibian, or reptile. This relationship holds for the smallest to the largest vertebrates that can be compared. For a given body weight, there is of course a spread of brain weights. Compared with the mammalian average, for example, a human has a brain six times as large as would be expected: humans are an extreme case in this regard. To express this, Dr. Jerison invented the term "encephalization coefficient" or "EQ." For humans, EQ=6. But note that EQ is for mammals. If a human EQ was measured on the reptilian scale, it would be 60.

Where do *T. rex* and other dinosaurs stand on Jerison's scale? The answer is not straightforward because we do not have any *T. rex* brains to measure directly. What we do have are cavities in the skull where we know the brain was located. If we were dealing with a mammalian brain, such a cavity would be a reliable surrogate for the actual brain, because a mammalian brain entirely fills the skull cavity in which it occurs. In reptiles, however, the situation is different. There, only about one-half to three-fifths of the cavity is occupied by the brain, and the rest of the space is given over to connective tissue.

Allowing for this uncertainty, *T. rex* had a reptilian EQ of about 1. If brain size is a meaningful measure of intelligence, *T. rex* was neither a mental giant among reptiles nor an exceptionally slowwitted beast. Living crocodiles have an EQ of 1 and have quite elaborate behavior patterns; they provide some parental care for their young and on occasion will hunt in groups. So it is reasonable to assume that *T. rex* had a similar level of behavioral sophistication.

In the Late Cretaceous of western North America, the most likely prey for *T. rex* would have been the duckbilled hadrosaurs and the horned ceratopsians such as *Triceratops*. Hadrosaurs had a reptilian EQ of 1, but the EQ of ceratopsians was only 0.2. Jack Horner

The Duel in Bronze, the Natural History Museum's new life-sized reconstruction of *Tyrannosaurus rex* and *Triceratops*, was rendered by Douglas Van Howd of Sierra Sculpture; Richard Campbell was production artist and engineer, and Kenneth Kirkland was consulting paleontologist.

The sculpture and its installation were made possible by Dr. S. Jerome and Judith D. Tamkin and the Tamkin Foundation, in honor of the Tamkin's grandchildren, Evan and Erin Harmon, Andrew and Lina Litvak, and William Catlett as well as present and future grandchildren of the County of Los Angeles.

Photographs of the Duel in Bronze by Curtis Dahl of Kaish Dahl Photography and Video, Beverly Hills and Tarzana.

has devoted much of his career to understanding hadrosaurs. One in particular, *Maiasaura* or "the good mother lizard," was so named because Dr. Horner found several independent indications that the maternal behavior of these dinosaurs was quite elaborate. Such capabilities imply that *Maiasaura* would also have had a sophisticated ability to avoid predators. Ceratopsians, on the other hand, with their smaller brains and presumably more limited behavioral flexibility, probably adopted a more rigid response to the presence of a predator the size of *T. rex*.

If *T. rex* was an active predator, it may well be that its techniques for dispatching hadrosaurs and ceratopsians were quite different. The jaw gape of *T. rex* was quite sufficient to span the neck of even the largest hadrosaur, enabling it to cut the blood vessels or spinal cord with a single bite. An adult ceratopsian on the other hand, with its thick neck and frill of bone around it together with horns on the front of the skull, would seemingly have been a difficult or impossible prey to attack and quickly dispatch, even for a predator as large as *T. rex*.

Following a suggestion of William Abler, Ralph Molnar has speculated that, in attacks on ceratopsians, *T. rex* may have employed a killing strategy similar to that of the modern Komodo dragon. This giant monitor lizard makes a superficial bite on its large prey and then withdraws from the still living victim to allow septic bacteria from its mouth to infect the wound it has inflicted. The Komodo dragon then follows its prey until the festering of the wound weakens the animal to the point where it can be readily dispatched. Perhaps *T. rex* did a similar thing when it preyed upon ceratopsians.

Jack Horner points out that the reduced forearms of *T. rex* might have made it incapable of being an active predator at all, the alternative being that it was a scavenger. That such differences of interpretation exist among currently active paleontologists exemplifies the uncertainty of reconstructing the habits of even the most extensively studied dinosaurs.

The Natural History Museum's mounted skeletons and new bronze restoration of *Tyrannosaurus rex* attacking *Triceratops* thus represent a hypothesis that must be considered subject to future review and revision. Certainly as posed, *T. rex* may be envisioned either as in the process of trying to inflict a single bite that will with time turn into a festering wound on its *Triceratops* prey or as about to make the final kill. It does go against the hypothesis that *T. rex* was a scavenger, but this is not a bad thing. Any interesting scientific hypothesis has a chance of being wrong. When a concept is so well established that it is beyond question, it is really of little interest to scientists except perhaps as a reliable building block to-

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ward the resolution of other, still controversial issues.

The first specimens of *T. rex* were collected by the American Museum of Natural History at the beginning of the twentieth century. In the 1960s, J. Reid Macdonald, then of the Natural History Museum of Los Angeles County, conceived the idea that the museum should have a specimen of *T. rex* for exhibition. So prospector Harley Garbani was sent out to eastern Montana to search for *T. rex* material. As a result, the museum recovered parts of two skeletons of *T. rex* plus a number of *Triceratops* specimens as well. This was the first additional material of *T. rex* found and collected anywhere since Barnum Brown had collected for the American Museum in the same area 60 years before.

In the 30 years since Garbani's excavations, much effort has been devoted to finding and collecting specimens of *T. rex*, and there are now parts of more than twenty-one individuals known from Alberta to Colorado. The fact that the last decade has seen the discovery and collection of nearly half the *T. rex* specimens now known is indicative of the widespread interest, both scientific and general, in this unique dinosaur. With its intriguing specialized adaptations, large size, and apparent ferocity, the Tyrant Lizard King tantalizes us all.

THOMAS H. RICH

Dr. Rich is Curator of Vertebrate Palaeontology at Museum Victoria in Melbourne, Australia. He and his wife, Patricia Vickers Rich (see accompanying article on *Triceratops*), *share an interest in the dinosaurs and other animals that lived in southeastern Australia during the Early Cretaceous, at a time when the area was well inside the Antarctic Circle.*

same territory. And once the species identification is taken care of, then the females well could have been impressed by bigger horns combined with dominant behavior: over time, more offspring would have carried the genetics of certain imposing males, and you have natural selection in action.

The bony horns found on fossil ceratopsian skulls are very likely just the cores of the protuberances that they had in life. Large sheaths like those on a modern cow would probably have covered the cores, extending out far beyond them and making these beasts look impressive indeed. I think of the bony skull and horn cores of a Texas Longhorn, then add to that the sheaths we see on the living animals, and can imagine the fierce visage left even on the small brain of a *Tyrannosaurus* by an adult male *Triceratops* that was very angry. I would never argue with a Texas Longhorn and definitely not with an angry *Triceratops.*

Triceratops was perhaps the only herbivorous dinosaur that could take on a *T. rex* and have any chance of winning. It was an animal adapted for standing and confronting its aggressor, not for taking flight and hoping to outrun it, as Peter Dodson points out in his new book on the ceratopsians, *The Horned Dinosaurs* (Princeton, 1998). In an earlier classic work, *The Dinosaur Heresies* (Longman Scientific & Technical, 1987), Robert Bakker concluded that *Triceratops* was well adapted for lunging and charging—it had a broad chest, a short torso, wide and strongly built hips, thick limbs, and forward-pointing horns. He also noted that fossilized ceratopsian trackways indicate animals that walked fairly erectly but were probably not given to running for long distances or periods.

Once beyond the horns, the next impressive part of *Triceratops* anatomy is the frill. What was it for? Again, scientists have disagreed, proposing that it was protection against the beast being bitten in the neck by *Tyrannosaurus* or an attachment for muscles or a surface covered with highly vascularized skin that would allow for some sort of thermoregulation. Heat up the blood by turning this huge surface area broadside to the morning sun, and bingo, *Triceratops* would have been ready to move at full speed. Likewise, with the surface oriented in another way or bathed by the wind, the frill could have allowed for cooling. Perhaps all these ideas have some merit.

Beyond the obvious about *Triceratops*—its three horns, huge size, and big frill, just what do we know about this flamboyant dinosaur? Quite a lot, actually. *Triceratops* belongs to a group of ceratopsians called the chasmosaurines (the long-frilled ceratopsians), which ranged over a wide area of North America, from Mexico to Alaska, and were successful somewhat later in time than the second group of ceratopsians, the shorter-frilled "centrosaurines." *Triceratops* survived into the latest Cretaceous times and, in fact, may have been one of the last of the "proper" dinosaurs (if we think of birds as "improper" dinosaurs!). As far as we know, *Triceratops* never set foot out of North America.

Triceratops remains are very abundant; the species is one of the better represented dinosaurs in museum collections. The great bone-hunter Barnum Brown of the American Museum of Natural History is quoted by Peter Dodson as saying that he had noted "no less than five hundred fragmentary skulls and innumerable bones referable to this genus" as he worked in Montana from 1902 to 1909. Even though this may be somewhat of an overstatement, Dr. Dodson notes that there are at least 10 percent that number of skulls documented in museum collections.

Much of the *Triceratops* material now in museums was recovered by John Bell Hatcher, a hero of mine and of other

field-oriented paleontologists. The man was a giant among collectors, even in his all too short life (he died of typhus while in his early forties). Hatcher graduated from Yale in the early 1880s and worked awhile for O. C. Marsh excavating in the American West. He is often remembered for his work in Patagonia, where he ran expeditions for Princeton, and he is renowned for supporting field operations on what he could win at poker in this wild southern part of the world. But he carried out significant field work in North America as well.

On a trip out west in 1888, Hatcher retrieved a fragment of a skull and two large horns. Returning east, he stopped in the town of Douglas, Wyoming, where he met a Mr. Charles Guernsey, a rancher who was also an impressive collector, given that he only was able to work in his spare time. In Mr. Guernsey's collection was an enormous horn core that had been found not far from Lusk. Peter Dodson recounts how this specimen was collected: "The boys [ranch hands] had seen a large head 'sticking out midway of the bank on one side of a deep dry gulch,' with 'horns as long as a hoe handle and eye holes as big as your hat.'" Evidently "the boys" had tried to capture the skull using a lariat—the single horn core was all that was unearthed using this somewhat rambunctious procedure.

Mr. Hatcher returned to the area of Wyoming where the horn had been exposed and continued to excavate there until 1892, when funds ran out. I remember hearing stories about John Bell Hatcher when I too worked in this part of the country in the late 1960s. He was known as the "one-man band" for collecting the enormous skulls of *Triceratops* by himself using wagon and pulley and tripod. Peter Dodson notes that Mr. Hatcher collected at least 50 ceratopsians, of which 33 were complete or nearly complete skulls, the largest weighing more than 3 tons. I have often been inspired by what Hatcher was able to accomplish working in this isolated part of Wyoming at a time when the country had no sealed roads, no 4-wheel drives, no power winches or jackhammers, and no roadside rest stops and with the nearest railhead 40 miles away across the rolling grasslands. You have to respect his determination and stand in awe at his successes.

When one tries to imagine *Triceratops* as an animal, perhaps the closest modern analogue is a big rhinoceros in all of its magnificence. One *Triceratops* specimen at the American Museum of Natural History (although admittedly a composite) is about 23 feet in length, with the highest point of the skeleton, at midback, more than 7½ feet off the floor. Another skeleton at the Science Museum in Minnesota is slightly longer (about 26 feet) and a little taller (9½ feet). For comparison, the largest of the rhinos is the African Black Rhinoceros, which is about 15 feet long and 5 feet high at the shoulder and weighs almost 2 tons. *Triceratops* was a sizeable animal—you would not have liked to have one step on your toes.

Triceratops has captured the imagination of not only the scientists and collectors who have sought its bones but also the artists, the movie makers, the toy and game designers, and just about every 6 year old that I have ever met. And this fame has been bestowed on a herbivore rather than on a ravaging killer. To a mother with a son, that is a nice thought.

PATRICIA VICKERS RICH

Dr. Vickers Rich is Professor of Palaeontology at Monash University in Melbourne, Australia. She received her master's and doctoral degrees in geology at Columbia University in New York. Her early work was on fossil birds, particularly those of Australia, but she now works with colleague and husband Thomas H. Rich (see accompanying article) *on polar dinosaurs, conducting field operations in Australia, Patagonia, and Alaska.*

MUSEUM ON THE MOVE

■ NEW ASSISTANT CURATORS

In September, at the conclusion of a nationwide search, the Natural History Museum welcomed two biologists to the staff of its Research and Collections Branch. Dr. Christine E. Thacker has accepted the position of Assistant Curator for Ichthyology. At the University of Michigan, where she received her Ph.D., Dr. Thacker was recipient of the Carl and Laura Hubbs fellowship. Her research focuses on the systematic relationships among gobies, an extremely diverse group of small, primarily marine fishes. She is also studying the evolution of various patterns of ontogeny—the development of an organism to maturity—and the evolution of miniaturization in fishes.

Dr. David A. Kizirian has been appointed Assistant Curator for Herpetology. Dr. Kizirian earned his doctorate from the University of Kansas in 1994 and comes to the museum from a position at the American Museum of Natural History. His research concerns the diversification of tropical amphibians and reptiles; he is particularly interested in how legless lizards evolved, the origin of all-female species, historical changes in the behavior and morphology of aquatic lizards, how habitat influenced the evolution of courtship and territorial displays in the lizards known as anoles, and speciation in Old World tree frogs.

■ LEPIDOPTERISTS HONOR CURATOR EMERITUS

Julian P. Donahue, Assistant Curator Emeritus for Entomology, was honored with the 1998 John Adams Comstock Award by the Pacific Slope Section of the Lepidopterists' Society. Established in 1947, the society is a worldwide organiza-

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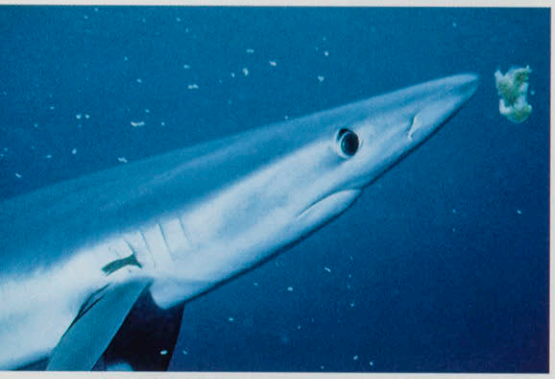
PROGRAMS FOR MEMBERS AND VISITORS

Educator workshop and field trip

■ SHARKS! FACT AND FANTASY

Saturday, November 7, 9 a.m. to 5 p.m., and Sunday, November 8, 6 a.m. to 4 p.m.

Learn the facts about sharks and shark behavior, and discover methods of integrating shark evolution, reproduction, and adaptation into your curriculum. Saturday's workshop will take place at the



COURTESY HYDROSPHERE

Museum of Natural History; on Sunday, we'll travel to Santa Catalina Island to dive with blue sharks. Protected in the water in a snorkeling cage, we will observe the sharks in their natural environment while assisting researchers from the Southern California Marine Institute in their ongoing juvenile blue shark tagging program. Marine biologists from the Hydrosphere team and museum educators will lead presentations and workshops as we travel to and from the island on board the *Pacific Explorer*. Breakfast and lunch on Sunday are included. $105 members, $115 nonmembers. Salary Point Credit is available; please call 213/763-3240 for more information.

Lecture and books signing

■ AN AMERICAN DREAMER

Saturday, November 7, 1 p.m., Connor Pavilion, Petersen Automotive Museum

Carl G. Fisher, a "practical visionary," created the first transcontinental highway, built the Indy 500, developed Miami Beach, and made Long Island a fashionable place to live. In this talk, Jerry Fisher, author of *The Pacesetter: The Untold Story of Carl G. Fisher* (Lost Coast Press, 1998), shares the fascinating story of one of America's great entrepreneurs. $7 members, $9 nonmembers, $5 students with I.D.

Lecture

■ BALLOON ARCHAEOLOGY

Minoan Crete from the Air

Sunday, November 8, 2 p.m., Jean Delacour Auditorium, Museum of Natural History

Dr. J. Wilson Myers, author of *The Aerial Atlas of Ancient Crete* (University of California, 1992) and member of the American School of Classical Studies at Athens, spent 5 years in Minoan Crete taking aerial photographs of palaces, settlements, and tombs. These images allowed archaeologists to study patterns and relationships at complex sites and preserve information otherwise lost through erosion or continued excavation. Instead of using high-tech methods such as satellite photographs or aerial shots from jet aircraft, Dr. Myers used radio-controlled cameras suspended from a tethered, unmanned balloon to obtain his pictures. In this beautifully illustrated lecture, he will describe the methods and results of his study. The event is cosponsored by the Archaeological Institute of America and is supported by the AIA's Martha Sharp Joukowsky Lectureship. $7 NHM/AIA members, $9 nonmembers, $5 students with ID.

Lecture

■ HART ON STAGE

Sunday, December 6, 2 p.m., Saugus Train Station, Hart Park

Dr. Abraham Hoffman, author of several articles on William S. Hart's life, explores the years that the Western silent screen actor and director spent on the stage. In this often overlooked but important period in Hart's career, he experienced all the joys and hardships of a road company actor. Dr. Hoffman is writing a biography of Hart, using the rich archive of materials in the Natural History Museum's Seaver Center for Western History Research, and he illustrates his talk with images and information from the Seaver collection. Birthday cake will be served after the talk, in celebration of "Two Gun Bill's" 134th birthday. $7 members, $9 nonmembers, $5 students with I.D.; for reservations, please call 213/763-3534 or 805/254-4584.

Lecture

■ THE RAPTORS OF RANCHO LA BREA

Sunday, December 6, 2 p.m., Page Museum

The bones of birds are rare in fossil deposits because their delicate structure reduces chances for preservation. But at Rancho La Brea, the asphalt provided a protective coating for the skeletons of birds that became trapped, and the tar pits have yielded more than 350,000 specimens, the largest collection of fossil bird bones found anywhere in the world. Dr. Kenneth Campbell, Curator of Ornithology at the Natural History Museum, provides an in-depth look at the raptors in this collection, including Golden Eagles and Bald Eagles and other species that persist today as well as extinct species, such as a fossil eagle known as *Wetmoregyps daggetti*, whose legs were as long as those of a Great Blue Heron. He also introduces us to other interesting species, such as Merriam's Teratorn, a predatory ground bird that weighed almost 30 pounds and had a wingspan of about 14 feet. $7 members, $9 nonmembers, $5 students with current I.D.

ADULT CLASSES

■ SEASHELLS BY THE SEASHORE

Orientation: Wednesday, November 18, 7 to 9 p.m. Field trip, Saturday, November 21, 2 to 5:30 p.m.

Dr. James McLean, Curator of Malacology at the Natural History Museum, describes the lifestyles of the organisms that produce "seashells" and leads a behind-the-scenes tour of the museum's marine mollusk collection, the third largest in the United States. On Wednesday, we will have rare after-hours look at the collection, which is worldwide in scope. The following weekend, Dr. McLean will join us on the Palos Verdes Peninsula, where we can see some local mollusks at work in their intertidal

HUNTERS OF THE SKY

The biology of raptors and the lengthy history of their interactions with people and their use as symbols in art and folklore around the world are the focus of an exhibition on display through January 3, 1999, at the Museum of Natural History.

In *Hunters of the Sky*, a large collection of mounted specimens highlights the biodiversitiy that exists among raptors. The exhibition explores the lifestyles of the birds of prey through recreations of nests and habitats, interactive stations, and displays of artifacts from many cultures. Impassioned and controversial conservation efforts on behalf of California Condors, Peregrine Falcons, Bald Eagles, and the Northern Spotted Owl are examined in videos that have been praised for their balanced presentations of the complex economic and ecological issues at stake. And at computerized polling stations, visitors are invited to consider and express their own opinions on environmental ethics and the role of humans in the natural world.

***Hunters of the Sky* was produced by the Science Museum of Minnesota in collaboration with the Raptor Center at the University of Minnesota. The exhibition is supported by major grants from the National Science Foundation and the National Endowment for the Humanities; additional funding is provided by Wildlife Forever.**

PHOTOGRAPH COPYRIGHT 1990 MANABU MIYAZAKI.

habitat. Participants provide their own transportation for the field trip. $20 members, $25 nonmembers. Space is limited.

■ LOOPED ROCK FETISH POUCHES

Saturday, December 5, 9 a.m. to 4 p.m., Page Museum

Learn one of the most ancient basketry techniques while creating a fetish pouch. We'll embellish our finished creations with beads, feathers, or cherished objects. Instructor Judy Mulford, basketry artist and educator, invites students of all skill levels. $50 members, $60 nonmembers.

ADULT FIELD TRIPS

■ TAKE FLIGHT IN THE ANTELOPE VALLEY

Saturday, November 21, 8 a.m. to 5 p.m.

The grasslands and agricultural fields of the Antelope Valley, a finger of the Mojave Desert that extends through northernmost Los Angeles County, are renowned for their concentrations of wintering birds of prey. Museum ornithologist Kimball Garrett leads a natural history tour of this rich region in search of Golden Eagles, Prairie Falcons, White-tailed Kites, Ferruginous Hawks, and a variety of other raptors. We will learn to identify these birds as we observe their foraging behavior and interactions with other species. Bring binoculars, a sack lunch, and water; the trip will depart from the Exposition Park museum at 8 a.m. $50 members, $60 nonmembers.

■ TRACKING THE MONARCH BUTTERFLY

Orientation: Wednesday, December 9, 7 to 8:30 p.m. Field trips: Saturday, December 12, 10 a.m. to 1 p.m. (children ages 10 and older, accompanied by an adult) and Sunday, December 13, 10 a.m. to 2 p.m. (adults)

Each year monarch butterflies living west of the Rockies migrate hundreds of miles to spend the winter on the mild California coast. At an over-wintering roost in Santa Barbara, we'll observe thousands of these delicate yet hardy insects. In the orientation class, Walt Sakai, a lepidopterist and

professor of life sciences at Santa Monica City College, will discuss the monarch's life cycle and migratory behavior. On the field trip, we'll learn to tag the butterflies so that naturalists can track their migration. Participants provide their own transportation to the site and a picnic lunch. $15 members, $20 nonmembers.

■ THE ARTS AND CRAFTS STYLE

Saturday, January 23, 1 to 5 p.m.

During the early decades of the twentieth century, the Arts and Crafts movement flourished in southern California. This artistic style, which showed itself in plein air painting, ceramics, and architecture and was centered around the Arroyo Seco, was a reaction to society's increasing mechanization. Dr. Robert Winter, architectural historian and author of a number of books on the movement, leads us on a tour of notable buildings from the era. We will visit the home of Ernst Batchelder, maker of the beautiful and renowned Batchelder tile, as well as the unusual home of Charles Lummis, founder of the Southwest Museum. Travel is by chartered motor coach. $35 members, $45 nonmembers.

FAMILY PROGRAMS

■ COLLAGE A CARD!

Saturday, November 14, 2 to 4 p.m., Petersen Automotive Museum. Children 5 and older, with accompanying adult

Happy Thanksgiving! Merry Christmas! Happy Hanukah! Wish your family and friends a joyful holiday season with your very own handmade card. Artist Sara Frank shows us the kinds of surprising materials you can use to create a festive greeting card. $3/card members, $4/card nonmembers. Fee includes materials.

Field trip

■ CONDORS AT THE ZOO

Sunday, November 15, 10 a.m. Children ages 5 and older, accompanied by an adult

Keepers at the Los Angeles Zoo will give us an exciting tour of the California Condor section and tell us about their breeding program. As you learn about captive breeding, rehabilitation, and the status of the wild condor populations, you will have the unique opportunity to view these stately birds of prey in their zoo habitats from behind the cover of blinds; we'll also visit the nursery and monitoring stations. $20 members, $25 nonmembers.

FAMILY FUNDAYS

These family programs are **free** with museum admission for children ages 4 and older. No reservations are necessary, but space in some programs is limited, so please arrive early.

■ THE FLIGHT OF THE CONDOR

Saturday, November 21, 1:30 p.m., Discovery Center, Museum of Natural History

Los Angeles Zoo Herpetologist Russ Smith tells us about efforts to save these endangered birds; a craft activity follows his presentation.

■ THE RAP ON RAPTORS

Saturday, December 5, 1:30 p.m., Discovery Center, Museum of Natural History

With Science Educator Molly Hogan, meet a live raptor from Wild Works; then make a craft item to take home.

■ RECYCLED CAR

Saturday, November 28, 2 p.m., Discovery Center, Petersen Museum

Recycle everything from film canisters to corks, and build your own distinctive vehicle.

Children's class

■ SHARP BEAKS AND TALONED FEET

Sunday, November 22, 10 a.m., Education Classrooms, Museum of Natural History. Children ages 6 to 8

Wildlife on Wheels Educator Michael Fritzen introduces us to the birds of prey. Falcons, hawks, and their relatives have unusual body features that make them perfectly suited for the kill. As you meet some live raptors, you'll get a close look at their hunting equipment. And by dissecting owl pellets, you'll find out exactly what a few hunters of the sky were able to catch. $20 members, $25 nonmembers.

OSPREY, KIMBALL GARRETT

■ HOLIDAY PHOTOS

Saturdays, December 5, 12, and 19, 2 to 4 p.m., Discovery Center, Petersen Automotive Museum

Looking for a perfect holiday photograph? Join us anytime between 2 and 4 p.m. on these Saturdays for a special photo session with the museum's 1910 Model T Ford. You can even make use of the May Family Discovery Center's costume collection to dress appropriately. $3 per photograph.

Family field trip

■ BALD EAGLES OF CACHUMA LAKE

Saturday, December 5, 12:30 to 4 p.m.

Come and spend a day on Cachuma Lake experiencing the amazing wildlife right here in southern California. The lake is host to a group of Bald Eagles that migrates

from as far away as Alaska to this winter home; over the last few years, some individuals have begun to stay on at the lake to rear their young. On our private cruise, we will not only have excellent viewing of the Bald Eagles but will also encounter other wildlife, such as Ospreys, Great Blue Herons, and deer, and we may catch a glimpse of mountain lions and bobcats. Prior to the cruise, we will have a tour of the Cachuma Lake Nature Center and a short nature hike with the center's naturalists. There are excellent camping facilities available for those who wish to make this a weekend excursion. $50 members, $60 nonmembers.

■ WINTER ADVENTURES IN NATURE

Monday, Tuesday, and Wednesday, December 28 to 30, Museum of Natural History

Children ages 4 through 11 can learn about nature firsthand in exciting participatory sessions with outstanding museum instructors. The day-long courses offer opportunities to work with natural history specimens and artifacts, visit curatorial laboratories, and make craft items to take home. Classes include:

Ages 3 to 4, with accompanying adult: Pint-sized Paleo, As Big as That?, Mudhens, Mudskippers, and Mud Pies

Ages 5 to 6, Rambunctious Reptiles, Let's Go Buggy, Dig Those Dinos

Ages 7 to 8, How Hot It Is, Ocean Oddities, Wild and Woolly

Ages 9 to 11, Discovery Detectives

Classes for children ages 7 and up, which are limited to twenty students each, run from 10 a.m. to 3 p.m. (students bring a bag lunch); each class is $40 members, $45 nonmembers. Classes for children ages 3 to 4 (with accompanying adult) run from 10 a.m. to noon; each class is $25 per child/adult pair, members; $30 per child/adult pair nonmembers. Classes for children ages 5 to 6 run from 10 a.m. to noon; each class is $25 members, $30 nonmembers. Discounts of $5 per class are offered when a child enrolls in two or more classes. For more information, please call 213/763-3534.

ANNOUNCEMENT

■ AN INVITATION TO SERVE

The four museums that make up the Natural History Museum of Los Angeles County offer a wide variety of volunteer opportunities to suit your interests and where you live in Los Angeles County. Volunteers are trained to be docents, curatorial helpers, or service council members or to conduct outreach programs. If you are fascinated by history or the natural sciences, the Natural History Museum family welcomes you. For further information, please call:

■ Newhall. William S. Hart Museum: Sheila Fernandez, 805/254-4584.

■ Miracle Mile. Petersen Automotive Museum: Helena Praks, 323/964-6347. Page Museum at the La Brea Tar Pits, Eileen Wallis, 323/857-6305.

■ Exposition Park. Isabel Rosenbaum, 213/763-3341.

PUBLIC PROGRAMS RESERVATION FORM

■ **By telephone:** Use your MasterCard or VISA. Call the Education Division at 213/763-3534, weekdays, 8 a.m. to 4 p.m. Credit cards are accepted only with a minimum charge of $20.

■ **By mail:** Complete the form below, fill in the charge information or enclose a check payable to Museum Foundation, and return your order form and payment with a self-addressed, stamped envelope. The form may be duplicated. Mail to: ***Education Division, Natural History Museum, 900 Exposition Boulevard, Los Angeles, CA 90007***

■ **Important: Reservation, Waiting List and Refund Policies.** Preregistration is required for all classes, workshops, and field trips and is recommended for all other Education Division programs. Tickets to auditorium events may be purchased at the door on a first-come, first-served basis; seating is not reserved. Reservations are not necessary for Family Fundays. Applicants for filled programs will be placed on a waiting list and contacted if vacancies or rescheduling occur. If you have paid for a filled program, your payment will be refunded in 4-6 weeks.

Cancellations must be made at least 6 business days prior to the first day of an event for the registrant to be eligible for a partial refund. No refunds can be given for cancellations made in the 5 days before the event.

Dates and times of programs are subject to change, and class sizes are limited. Please call 213/763-3534 weekdays between 8 a.m. and 4 p.m. to verify program dates, times, and availability.

■ **Special Assistance Available.** If you wish to attend a museum event and require auxiliary aids or services, please contact the museums' Americans with Disabilities Act (ADA) Compliance Officer at least three (3) business days prior to the event. The ADA Compliance Officer may be reached by telephoning 213/763-3417 (voice) or by calling that number via California Relay Service at 800/735-2929 (TTY).

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TRAVEL OUT OF THE ORDINARY . . .

Get off the beaten paths, and discover worlds apart!

The Natural History Museum has an exciting new program of travel, with an array of unusual destinations and customized itineraries specifically tailored to our sophisticated Museum Members.

Each of our plans features an asset that only we can offer—you are accompanied on your trip by one of the museum's own experts, carefully chosen to add knowledgeable perspective and uncommon dimensions to your experience.

Contact our travel office today, and take the first steps toward an extraordinary adventure with the Natural History Museum.

Mexico City, Teotihuacán, and 100 million Monarch butterflies, February 16 to 21, 1999 from $1,490* plus airfare

A cruise along Costa Rica and Panama, with stops in exquisite bays and anchorages, April 3 to 11, 1999 from $3,440* plus airfare

To receive a detailed brochure on 1999 museum travel opportunities or obtain more information about a specific destination shown here, please call Christine Robison at 213/763-3350.
Or visit our Web page at www.nhm.org/travel.

An Oceanic Society Expedition to Midway Atoll, April 10 to 18, 1999 from $2,425* including roundtrip airfare from Honolulu to Midway

Photographs copyrighted, used with permission: Monarch butterfly sanctuary in Morelia, Julian P. Donahue. Costa Rica and Panama, John Hopper. Midway Atoll, Birgit Winning, Oceanic Society Expeditions.

*Price per person, all accommodations and land transport included.

MUSEUM ON THE MOVE CONTINUED

continued from page 9

tion of amateur and professional lepidopterists. The award, named after a former curator and division head at the Natural History Museum, is presented annually to an individual in western North America for distinguished contributions to the study of western moths and butterflies or outstanding service to the society. Mr. Donahue, a specialist in moths, has held a number of offices in his 37 years as member of the society; he has been assistant secretary in charge of the membership database since 1986.

■ HUNTINGTON FELLOWSHIP AWARDED TO CURATOR

Dr. Janet R. Fireman, Curator of History, was awarded a Huntington Fellowship for summer 1998. During her 3-month residency at the Huntington Library and Art Gallery, she worked on a manuscript by John Hovey, an Argonaut who travelled to California in 1849. Dr. Fireman is editing Mr. Hovey's diary, which includes 41 watercolors by the author; a working title for the published work is *Animal, Vegetable, Mineral: John Hovey's Illustrated Gold Rush Diary.*

Dr. Fireman, who is president of the Western History Association, is currently serving on an advisory committee for a special exhibition being developed by the Huntington. *Land of Golden Dreams: California in the Gold Rush Decade, 1848–1858,* will open at the San Marino institution in October 1999 and run through September 2000

■ RARE SEAL ADDED TO COLLECTIONS

A complete skeleton of an endangered Hawaiian monk seal, *Monachus schauinslandi*, was recently added to Mammalogy's extensive marine mammal collections. The declining population of Hawaiian seals now numbers about 1,400 individuals. The rare monk seal, which probably occurred throughout the Hawaiian Island chain prior to the arrival of humans, is today restricted to the sparsely populated outer Leeward Islands, where the animal whose remains are now in the museum's collection was found dead.

NEW "TARPITS" WEB SITE

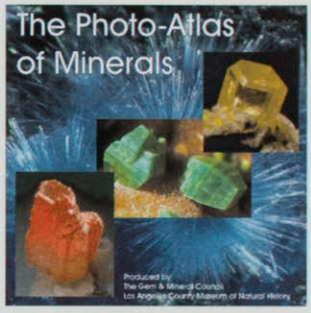
The Natural History Museum is pleased to announce completion of a web site for the Page Museum at the La Brea Tar Pits. The new site includes information about the Page Museum and the asphalt deposits as well as photographs of early excavations at Rancho La Brea that were recently donated to the museum by the Gilbert family.

The web site was designed by Yoshi Fukumoto, an intern from the University of California, Santa Barbara, who worked in the Natural History Museum's Information Technology Laboratory in summer 1998. The site can be viewed at www.tarpits.org.

PHOTO-ATLAS OF MINERALS

The Photo-Atlas of Minerals, a CD-ROM for Windows produced by the Natural History Museum's Gem and Mineral Council (see TERRA, January/February 1998, p. 14), is now available for $49.95 through the Natural History Museum gift shops; it may also be ordered by contacting the museum's Gem and Mineral Council at 213/763-3326 or at www.nhm.org/~gmc.

The photo-atlas is the world's most complete pictorial reference on minerals. It features more than 6,500 high-resolution images, descriptive data for all minerals, name pronunciations in audio format, and mineral localities with index maps. The CD-ROM also includes an extensive glossary of mineral terminology, copying and printing capabilities, and a mineral identification game.



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This holiday season, surprise someone special with a membership in the Natural History Museum—and receive discounts on your own membership renewal! Among the many benefits that your gift includes are free admission to four museums, a subscription to TERRA, invitations to members-only events, discounts on educational programs, and exciting travel opportunities. And from November 15 through December 16, for each gift membership that you purchase (to a maximum of two), we'll send you a coupon for $10 off on renewal of your own membership. To receive discount coupons, gift memberships must be purchased by December 16, 1998. There is a limit of two discount coupons per member, for a total of $20 off on your renewal. Renewal discount coupons may be redeemed at any time.

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The Natural History Museum exists to advance knowledge and to enable people of all ages, backgrounds, and interests to understand and appreciate their natural and cultural heritage. The museum assembles, conserves, interprets, and holds in trust collections of irreplaceable objects from nature and human history. These collections reveal the history of the Earth and the evolution and diversity of life and culture. They sustain programs of research, exhibits, education, and publication.

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General information 213/763-DINO

■ Page Museum at the La Brea Tar Pits
5801 Wilshire Blvd., Hancock Park, Los Angeles 90036
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■ William S. Hart Museum
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Exposition Park, Los Angeles, California 90007

TREASURES from HARMONY KINGDOM

This holiday season, we invite you to discover the hidden secrets of Harmony Kingdom's Original Box Figurines. This collection of whimsical figures is the result of a unique collaboration of artists from Great Britain's West Country, who hand-sculpt the wax masters for each piece in time-honored tradition.

"Jingle Bell Rock" and **"La Gardienne"** are the 1998 special holiday edition pieces. Limited to a 1-year production cycle, the molds for these lovely boxes will be broken at the close of this year.

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